PATENT APPLICATION

SKYLIGHT SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the filing of U.S. Provisional Patent Application Serial No. 60/444,128, entitled "Skylight", filed on January 31, 2003, and the specification thereof is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention (Technical Field).

The present invention relates, generally, to a method and apparatus for a tapered tubular skylight system and a permanently sealed skylight system.

Description of Related Art:

Note that the following discussion refers to a number of publications by author(s) and year of publication, and that due to recent publication dates certain publications are not to be considered as prior art vis-a-vis the present invention. Discussion of such publications herein is given for more complete background and is not to be construed as an admission that such publications are prior art for patentability determination purposes.

With a typical tubular skylight, a hole is cut into the roof of the structure and a flashing is then secured over the hole. A reflective cylindrical light tube is lowered through the flashing with a clear dome attached to the top. Inside, a diffuser is added to the bottom of the light tube along with safety wires that connect the diffuser to the ceiling, thus allowing natural light to enter the building.

There are many problems with this type of system, namely product design, wasted installation time, shipping and storage. Installing a clear outer dome causes much of the early morning, evening, and low winter light to pass through the dome, not down the light tube. When

a reflector is used in the dome to catch low angled light, it will also deflect some light from the light tube during peak summer hours. Securing the outer dome to the flashing with screws or bolts consumes time and tends to crack the outer dome at the points of pressure. Also, in this area where the dome meets the flashing, small holes or slits are used in an effort to keep out condensation that builds up inside tubular skylight systems. The holes allow the system to breathe, exhaling in the heat of the day, and inhaling moisture, dust, bugs, and other contaminates at night, which in time ruins the highly reflective light tube.

A flashing has two purposes, to provide a base to attach the light tube and dome, and to cover up mistakes made in cutting the hole in the roof by the installer. The flashing is a waste of time and money. The light tube's straight cylindrical shape causes many problems. If shipped to the job site already assembled, much space is taken up for this shipping. If the assembly is done on the job, usually a foil tape is used, which has been shown to undo over time. Therefore, safety wires must be installed on the inside of the building connecting the bottom of the tube to the ceiling to prevent the tube from falling. This causes a safety hazard and is unsightly.

The present invention overcomes these problems by providing a permanently sealed, tubular skylight system with a fully diffused (e.g. polycarbonate) outer dome, and a tapered light tube. No flashing is necessary, it is easily assembled on site, and easy to ship and store.

A tapered skylight system is described in U.S. Patent No. 6,363,667, entitled "Passive Collimating Tubular Skylight," to O'Neill. However, the taper is wider at the bottom than at the top.

American Manufacturing & Marketing System produces a "Square-Flex" skylight system with a flexible light tube.

A skylight system with a higher back than front is disclosed in U.S. Patent No. 6,604,329, entitled "Light Conducting Tube for a Skylight," to Hoy et al. However, the skylight is cut on site to match the pitch of the roof.

Several patents show various features of skylights and other roof accessories as follows: U.S. Design Patent No. D464,436, entitled "Collapsible Skylight Tube Having Open Ends and a Light Reflecting Inner Surface," to Hoy et al., shows a collapsible skylight with an light reflecting

inner surface. U.S. Patent Publication No. US 2002/0051297, entitled "Light Conducting Tube for a Skylight," to Hoy et al., also shows a light tube with light reflecting inner surfaces. U.S. Patent No. 6,385,922, entitled "Solar Light Receiving and Side Emitting System," to Mors, also discloses a skylight system with light reflecting interior surfaces. U.S. Patent No. 5,896,712, entitled "Light-Collecting Skylight Cover," to Chao, describes a skylight system with light redirecting and a diffuser. U.S. Patent Application Publication No. US 2003/0079422, entitled "Tubular Skylight for Lighting Rooms with Natural Light," to Bracale, discloses a skylight with reflective inner surfaces and a diffuser. U.S. Patent No. Re. 36,496, entitled "Skylight," to Sutton, describes a skylight with a reflector. U.S. Patent No. 5,175,967, entitled "Natural Light Distributing Apparatus," to Greenwood, discloses a skylight tube with mirrored interior surfaces. U.S. Patent No. 5,027,566, entitled "Window with Reflective Enclosure," to Gilowski, describes a window/light tube arrangement. U.S. Patent No. 4,114,186, entitled "Lighting Fixture," to Dominguez, discloses a skylight with a liftable lid. U.S. Patent No. 6,256,947, entitled "Method and Apparatus for a Tubular Skylight System," to Grubb, discloses using a prismatic diffuser. U.S. Patent No. 6,044,592, entitled "Nest of Curbs," to Strieter, describes a nest of roof curbs for roof-top mounting of equipment.

None of these prior art systems describe a tapered skylight, with the taper being wider at the top than the bottom. Nor do any of these prior art system disclose a permanently sealed skylight system.

BRIEF SUMMARY OF THE INVENTION

The present invention relates to a skylight system. The preferred skylight system comprises a tapered light tube comprising a top and a bottom, with the taper wider at the top than at the bottom. The skylight system further preferably comprises a dome at the top of the light tube. This dome preferably comprises a diffused dome, and most preferably a completely diffused dome on its interior. The diffused dome also preferably comprises a prismatic diffuser

The skylight system also preferably comprises a diffuser at the bottom of the light tube. This diffuser preferably comprises complete diffusion on its interior. The bottom diffuser also preferably comprises a prismatic diffuser.

In the preferred embodiment, the skylight system comprises a tapered light tube, a top dome disposed at the top of the tapered light tube, and a bottom diffuser disposed at the bottom of the tapered light tube. The tapered light tube is preferably sealed to the top dome. Likewise, the tapered light tube is preferably sealed to the bottom diffuser. This results in a completely sealed skylight system.

The dome, the tapered tube and the bottom diffuser are each preferably stackable during shipping and storage with other similar components. The top dome and/or bottom diffuser preferably comprise a notch system. The tapered light tube is disposed within the notch system. This notch system may comprise a gasket.

The light tube preferably comprises a reflective interior.

The back of the top of the light tube may be higher than the front of the top of the light tube.

The present invention is also directed to a permanently sealed system, whether or not the light tube is tapered. In this embodiment, the skylight system comprises a light tube comprising a top and a bottom, a dome disposed at and sealed at the top of the light tube, a diffuser disposed at and sealed at the bottom of the light tube. This combination of the light tube, top dome and bottom diffuser are permanently sealed.

The light tube, dome and bottom diffuser are preferably as described above.

The present invention is also directed to a method of assembly of a skylight system on a roof. The skylight system, as described above, is utilized. The diffuser is disposed on the light tube at the bottom of the light tube. A hole is cut in the roof. The skylight system is lowered through the hold in the roof. Then, the dome is disposed atop the light tube.

The light tube may be tapered, as described above. In this case, when the skylight system is lowered through the roof, the roof stops the tapered light tube at the portion where the light tube taper is the same as the roof hole.

In the preferred embodiment, the diffuser is permanently sealed to the light tube. Likewise, the dome is preferably permanently sealed to the light tube. This results in a permanently sealed skylight system. The dome and/or diffuser may have a notch and gasket system, as described above, to assist in sealing the components together.

A primary object of the present invention is to provide a skylight system with excellent light characteristics that is easy to manufacture, store, ship and assemble.

A primary advantage of the present invention is that it requires no roof flashing materials, is safe, and is sealed.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The accompanying drawings, which are incorporated into and form a part of the specification, illustrate one or more embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating one or more preferred embodiments of the invention and are not to be construed as limiting the invention. In the drawings:

Fig. 1 is a side view of the preferred skylight system of the present invention, shown fully assembled;

Fig. 2 is a cut-away view of the outer dome connected to the light tube of the Fig. 1 embodiment; and

Fig. 3 is a cut-away view of the bottom diffuser connected to the light tube of the Fig. 1 embodiment.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a skylight system that has a tapered light tube that is wider at the top than at the bottom. The skylight system of the present invention is useful for

commercial, industrial, residential structures, out-structures, sheds, or any structure requiring light.

The preferred embodiment is shown in the drawings. As shown therein, Fig 1 show the preferred skylight system in an assembled configuration, showing light tube **10**, outer dome **20**, and bottom diffuser **30**. Fig. 2 shows the preferred attachment of outer dome **20** to light tube **10**. Fig. 3 shows the preferred attachment of bottom diffuser **30** to light tube **10**.

As shown in Figs. 1-3, skylight system comprises top dome **20** with dome lip **23**; tapered light tube **10** with the taper wider at top **16** than at bottom **18**; and bottom diffuser **30** with diffuser lip **33**. The three separate components, top dome **20** (with dome lip **23**), tapered light tube **10** and bottom diffuser **30** (with diffuser lip **33**), are preferably shipped to the site and then assembled on site. Top dome **20** is snapped or sealed onto light tube **10**. Likewise bottom diffuser **30** is snapped or sealed onto light tube **10**. Inner lips **23** and **33** snugs light tube **10** to dome **20** and diffuser **30**, respectively. This makes a fully assembled skylight system (see Fig. 1). This skylight system is then inserted into a roof hole until the taper of light tube **10** is stopped (due to it being wider at top **16** than at bottom **18**) by the roof. The taper in light tube **10** makes it impossible to fall through the opening in the roof.

Since top dome **20** is a dome, it can be stacked with other similar domes for shipping and storage. Likewise, diffuser **30** has a dome or concave shape that can be easily stacked for shipping and storage. Also, tapered tube **10**, due to its tapered shape, can be stacked within other tapered tubes for shipping and storage.

Light tube **10** is preferably permanently sealed at the factory. Light tube **10** is preferably made of a strong material, such as heavy gauge aluminum, steel, plastic, or other structural material. Light tube **10** preferably has highly reflective material inside (e.g. Spectralight, Mylar, acrylic, mirror, and the like, or just a highly polished surface, e.g. highly polished aluminum, etc.). Using heavy gauge aluminum permits the light tube to also serve as the "flashing," saving time and money. Shipping and storage are easy since one light tube can nest inside another light tube. Also, being tapered in shape allows it to be assembled at the factory using state of the art adhesives, insuring a permanent seal. Being permanently sealed with adhesives helps eliminate

crack formations caused in polycarbonates by using screws, and prevents outside elements from tarnishing the highly reflective interior of the light tube. The light tube is preferably square or rectangular and tapered, and the interior surface of the light tube reflects the diffused light to bottom diffuser **30**. Light tube **10** has a taper that is wider at top **16** than at bottom **18**.

Top outer dome **20** is preferably fully or completely diffused. It should be made of an appropriate material for such diffusion, such as polycarbonate. Dome **20** is preferably made of an opaque or translucent structural material so that light can shine through. Outer dome **20** is preferably fully diffused, using a diffused pattern **22** (see Fig. 2), helping to channel or refract substantially more natural light into light tube **10** from low or high angles of the sun's rays. Outer dome **20** may be round in shape, a tapered flat shape, oval, flat, or any other shape desired.

Figs. 2 and 3 illustrate how light tube **10** is preferably attached to top dome **20** (Fig. 2) and bottom diffuser **30** (Fig. 3), without the need for fasteners (e.g. screws, roof flashing, etc.). Concerning Fig. 2, light tube **10** has a raised dimple **15** used to hold outer dome **20** in place. Dome **20** with channel **27** holds gasket **24** (e.g. neoprene gasket). Out bottom lip **26** is built up to hold raised dimple **15** in place with pressure from inner lip **28**. Fig. 2 also shows diffused texture **22** used on dome **20** other than dome lip area **23**.

Likewise, as shown in Fig. 3, light tube **10** with raised dimple **17** holds diffuser **30** in place. Diffuser **30** with channel **37** holds gasket **34** (e.g. neoprene gasket). Outer bottom lip **36** is built up to hold raised dimple **17** in place with pressure from inner lip **38**. Fig. 3 also shows diffused texture **32** used on diffuser **30** other than diffuser lip area **33**. The channels allows the dome and diffuser to be snapped into place, creating a permanent seal and eliminating pressure cracks that screws are known to cause in the prior art.

Outer dome **20** is preferably made of UV blocking material (e.g. polycarbonate) insuring many years of service. Top dome **20** is preferably fully diffused to capture exterior light from various angles and provides for more even lighting from bottom diffuser **30**. This also helps reduce internal heat in the skylight system and the need for vent holes. Top dome **20** preferably comprises a prismatic material to diffuse exterior light rays into the light tube from all angles.

Although the preferred embodiment provides for fully diffused top dome **20**, the invention also contemplates partial or no diffusion for the top dome.

The interior surfaces of light tube **10** reflect diffused light to bottom diffuser **30**. As the light leaves bottom diffuser **30**, it illuminates the surroundings. Bottom diffuser **30** is made of a diffuser material and preferably has a prismatic diffuser inside to produce excellent light quality. Bottom diffuser **30** should be made of an appropriate material for such diffusion, such as acrylic. Bottom diffuser **30** is preferably made of an opaque or translucent structural material so that light can shine through. Bottom diffuser **30** is also preferably rounded or squared and tapered, and it is preferably sealed to the light tube **10** so that it does not gather insects or dust.

In the preferred embodiment, shown in Fig. 1, tapered light tube **10** has a higher back **12** than front **14**. Dome **12** is configured to match sloping light tube **26**. Dome **12** and diffuser **32** attach to tapered light tube **26**, as described above. This slope captures the sun's rays better, allowing for more light to travel through the skylight system. The lower front preferably points south to improve sunlight collection at higher latitudes during the winter months. A flatter light tube top can be used when installing closer to the equator. Although the preferred embodiment shows tapered light tube **10** with a higher back **12** than front **14**, other configurations are useful in accordance with the present invention, and the invention is not limited to the configuration shown in the drawings. The top of the light tube may be flat, or the back of the light tube may be lower than the front of the light tube, depending on the building structure, roof system, direction towards the sun, etc.

At the job site, diffuser **30** and dome **20** with notched channels and neoprene gaskets are snapped onto light tube **10**. Cement or sealants may be utilized to seal dome **20** and diffuser **30** to light tube **10**, creating a permanently sealed unit. Adhesives may also be used to cement light tube **10** to the roof. Not using tape or screws eliminates condensation, dust, bugs or any other contaminates from affecting the highly reflective inside of the skylight system. This sealed system also acts as an excellent insulation barrier allowing minimal heat gains in the summer, or heat loss in the winter.

With the use of proper tools to cut a hole (square, rectangular, circular or other tubular configuration) in the roof, the skylight system is put into the hole without the fear of it falling, or the need for safety wires, or inside work. This is because of the taper of light tube **10** being wider at top **16** than at bottom **18**. Using a square or rectangular-shaped light tube makes installation much easier because a square or rectangular shaped hole is easier to cut than a round hole. However, the invention is intended to cover any other shape of skylight that is preferred (e.g. round, oval, polygon, free-form, etc.). On pitched roofs, a rectangular hole is usually preferably, enabling the skylight system to remain plumb. The tapered skylight system, with bottom diffuser **30** already attached, is placed into the roof opening. A holding device may be temporarily placed inside light tube **10** at the roof level to firmly hold it against the roof. A high-speed wire wheel may be used the clean the area between the roof and light tube "flashing" before any adhesive is applied. Adhesive is then used to cement the skylight system to the roof. A first adhesive is preferably applied. After a second thicker application of adhesives has cured, the holding device may be removed, along with any interior protective film. Finally, top dome **20** is snapped into place and preferably fastened with adhesives, sealing the skylight system to complete the installation. From the ceiling, one preferably only sees bottom diffuser **30**. From the roof top, one preferably sees top dome and at least a portion of light tube **10** (the portion of the taper that is wider than the roof opening). This portion of light tube **10** that can be soon on the roof can be minimized or maximized with the length of light tube **10** and taper of light tube **10**, depending on what is desired.

With only the use of adhesives and/or snap-on features, a completely sealed installation is easily and quickly achieved. No flashing, screws, etc. are required to install, position, hold or seal the skylight system onto the roof. The tapered shape also allows for all work on the skylight system to be done on the roof, since no safety wires are needed to be attached from the bottom of the skylight system to the ceiling. Permanently sealing the unit provides advantages over tape as in the prior art (e.g. foil tape), which tends to deteriorate over time causing contamination of light tubes. Screws, tape, roofing tar and silicone may be eliminated, allowing for superior

adhesives to be used. No safety wires are required to be attached from the ceiling to the light tube.

One embodiment allows use on structures with little or no space between the ceiling and the roof. This configuration is typical in large warehouse type buildings. Because of the need to direct light rays into the light tube, it has been found that by diffusing all the light before it enters the light tube reduces the internal heat, permitting one to use a shorter light tube, and still keep the bottom diffuser evenly lit. By using a prismatic diffuser for the complete interior of the top dome, three advantages are achieved: 1) it directs light rays from any angel down into the light tube; 2) It permits the use of a shorter light tube and still maintains an evenly lit bottom diffuser (this is because the light rays are broken up and deflected into different angles before entering the light tube); and 3) By softening the light rays with a diffused dome, internal heat is reduced to a point that no vent holes are required, making a totally sealed unit fully operational.

An inert gas (e.g. argon) may be put inside the light tube at the final sealing. A desiccant may be included to prevent condensation from forming inside the skylight system.

The skylight system of the present invention is an easy and economical unit to manufacture, ship, store and assemble. The square tapered light tube, with diffusers on the top and/or bottom of the system, and being permanently sealed, provide an improved skylight system, with a longer life. The system never requires the removal of the bottom diffuser to clean out dust and dead bugs. Most importantly, the skylight system produces an exceptional amount of light.

The skylight systems are constructed primarily with the roof thickness and slope in mind. The light tubes can therefore range from between 6" to 60" in height, and preferably approximately 30" in height for warehouse situations.

Example

A skylight was constructed as follows. First, the completely prismatic top dome was made from polycarbonate plastic that was squared and tapered in shape with an inner lip that fit the light tube tightly to the dome. Second, a square flashing light tube that was tapered, from a

larger top to a smaller bottom, was made from heavy gauge sheet aluminum, which became the "flashing" and the highly reflective interior surface. Next, a bottom diffuser was cemented with sealants to the aluminum light tube to create a permanently sealed unit. The dimensions of this skylight were 24" x 24" x 5" height for the top dome; 24" x 24" at the top of the taper, 20" x 20" on the bottom, and 30" in height; and the bottom diffuser was 20" x 20" x 2" depth.

Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover all such modifications and equivalents.